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THE 2017 FRASER SOCKEYE SALMON (*ONCORHYNCHUS NERKA*) INTEGRATED BIOLOGICAL STATUS RE-ASSESSMENT UNDER THE WILD SALMON POLICY

Figure 1. Sockeye salmon adult spawning phase. DFO website.

Figure 2. Sockeye salmon spawning locations in BC.

Context:

Canada's Wild Salmon Policy's (WSP) identifies six strategies for implementation. Strategy 1 is "standardized monitoring of wild salmon status" for Pacific Salmon conservation units (CUs). The first group of WSP biological status assessments for Pacific salmon were conducted on Fraser Sockeye Salmon in 2012 (DFO 2012). Subsequently, status assessments have been completed for Interior Fraser Coho Salmon (DFO 2015) and Southern BC Chinook (DFO 2016). Since greater than one generation (four years) has passed since the last Fraser Sockeye Salmon status assessment and Fraser Sockeye Salmon CU productivity has generally changed during this period, a re-assessment was initiated. Since WSP status integration methods were previously reviewed and approved through CSAS, the WSP status re-assessment was streamlined (fewer participants and shorter meetings) from the initial assessment. One new addition to the re-assessment in 2017 was the application of abundance benchmarks for cyclic Fraser Sockeye Salmon CUs that have stock-recruitment data. Cyclic CUs of Fraser River Sockeye Salmon are characterized by cyclic dynamics in spawner abundances on a 4-year (1-generation) time frame, consisting of 4 cycle lines for each of the 4 years within a cycle. The dominant cycle line is consistently at high abundances, the sub-dominant line at moderate abundances, and the two off-cycle lines at low abundances. For all CUs, the combination of a status, data summaries, and narratives are recommended as inputs into WSP Strategy 4 on Integrated Planning. As a package, this information can guide recovery actions among the Red, Red/Amber, and possibly Amber CUs, where applicable, and also guide management actions (fisheries, enhancement, and habitat) that affect CUs in any status zone. This Science Advisory Report is from the June 6 and 7, 2017 Fraser Sockeye Wild Salmon Policy Integrated Biological Status Re-Assessment. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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Canada

SUMMARY

- This SAR reports on the first re-assessment of biological status under the Wild Salmon Policy (WSP). This work was completed for 24 Fraser Sockeye Salmon Conservation Units (CUs) in 2017, which updates the previous statuses for these CUs (DFO 2012).
- The status re-assessment process identified the following integrated statuses for Fraser Sockeye Salmon CUs (see Table 1 for CU descriptions and Table 2 for statuses):
  - Seven Red; given the small distribution of the Widgeon-(river-type) CU, this CU will remain consistently Red; two Red/Amber; five Amber; six Amber/Green; three Green; and one data deficient.
- To enable status comparison for fisheries management applications, CUs were grouped into their four management groups: Early Stuart (EStu), Early Summer (ES), Summer (S), and Late (L). The status for the following CU's changed from 2012 to 2017 (Tables 2 and 4):
  - Status improved for six CUs: Nahatlatch-ES, Nadina-Francois-ES, Francois-Fraser-S, Chilliwack-ES, Anderson-Seton, and Pitt-ES.
  - Status declined for six CUs: Harrison (upstream)-L, Shuswap-ES, Lillooet-Harrison-L, Harrison (downstream)-L, Seton-L, and Shuswap-L.
  - Status did not change for 12 CUs:
    - five CUs remained Red: Bowron-ES, Cultus-L, Takla-Trembleur-EStu, Taseko-ES, and Widgeon-(River-Type);
    - two CUs remained Red/Amber: Quesnel-S and Takla-Trembleur-Stuart-S;
    - two CUs remained Amber: North Barriere-ES and Kamloops-ES;
    - two CUs remained Green: Chilko-S/Chilko-ES and Harrison-River Type;
    - Chilko-ES remained data deficient.
- Consistent with past WSP status assessments, this 2017 process concluded that no single algorithm can be developed to integrate status. Therefore, expert judgment is required to integrate status across metrics and supporting information for each CU.
- For Fraser Sockeye Salmon cyclic CUs with stock-recruitment data, new Larkin-model derived abundance benchmarks were included in the status assessment process. Cyclic CUs are characterized by a repeating pattern of one very high abundance year, and three smaller years. For these CUs, density-dependent interactions between cycle lines is assumed. Cyclic CUs include: Shuswap-ES (i.e., Scotch and Seymour), Shuswap Complex-L, Chilliwack-ES, Takla-Trembleur-E St, Takla-Trembleur-Stuart-S, and Quesnel-S. Unique to cyclic CUs, abundance benchmarks and statuses are estimated for each of the four cycle lines. When applied in the expert-driven context, Larkin-model benchmarks for cyclic CUs are recommended for future status assessments.
- In addition to status designation, narratives on the factors that contributed to these statuses are provided for each CU (Table 3). The combination of CU statuses, data summaries, and narratives are recommended as inputs into the WSP Strategy 4 on Integrated Planning to guide recovery actions (CUs in Red to potentially Amber zones), and management actions (fisheries, salmonid enhancement, and habitat) that affect CUs in any status zone.
- This work demonstrates that re-assessment processes can be conducted with less effort (e.g. fewer than 9 individuals participating in a 1 day meeting for Fraser Sockeye Salmon),

compared to first-time WSP status assessments (e.g. approximately 30 individuals over a 3 day meeting for Fraser Sockeye Salmon).

- It is recommended that data summaries be updated annually and that re-assessments be conducted every generation or when notable changes in CU productivity have occurred.

INTRODUCTION

The goal of the Wild Salmon Policy (WSP) is *'to restore and maintain healthy salmon populations and their habitats for the benefit and enjoyment of the people of Canada in perpetuity'* (Fisheries and Oceans Canada 2005). In order to achieve this goal, the WSP outlines a number of strategies, including Strategy 1 (Standardized Monitoring of Wild Salmon Status), which is applied to Fraser Sockeye Salmon in this review process. Work on Strategy 1 (WSP 2005) has progressed since the WSP was published in 2005, with the completion of the following peer-reviewed milestones:

- The identification of Pacific salmon CUs, technical background for WSP status assessments, methodology for the assessment of Pacific salmon biological status under the WSP, and compilation of required information to support WSP status assessments for Fraser River Sockeye Salmon CUs, including uncertainties (DFO 2012).
- A revised CU list for Fraser River Sockeye Salmon, identified relevant metrics and supporting information required to assess status, and appropriate data and data treatment approaches.
- Completion of the first integrated status assessment using Fraser River Sockeye Salmon CUs as case studies (Grant and Pestal 2012); subsequent status assessments were completed for Interior Fraser Coho Salmon(DFO 2015) and southern BC Chinook Salmon (DFO 2016), resulting in data summaries, statuses, and narratives for these CUs.

Specifically for Fraser Sockeye Salmon CUs, biological status was evaluated using abundance (where stock-recruitment or lake-rearing capacity data were available) and trends in abundance metrics, in addition to supplemental data and information. For each metric, a lower benchmark and upper benchmark delineate, respectively, the Red to Amber and Amber to Green status zones. These biological benchmarks are specifically used for status assessments, and are not prescriptive for specific management actions (Holt and Irvine 2013). They are also designed to be more conservative than the criteria established by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), as required by the WSP.

The status for each metric, which can vary from Red to Green, and related supporting material (data and information) presented in standardized data summaries is integrated into a CU status using expert judgment. Although the supporting material is not categorized into WSP status zones, it provides helpful context for status evaluations. The synthesis of the expert judgment on a CU's status is captured in the status narratives. These outputs are required for the implementation of subsequent WSP Strategies (e.g. Strategy 4, Integrated Strategic Planning) to prioritize assessment activities and management actions (fisheries, hatchery enhancement, and habitat).

The current 2017 re-assessment of Fraser Sockeye Salmon CU status was motivated by the five additional years of data now available, and by the general changes in productivity exhibited by most of these CUs in recent years (DFO 2017).

ASSESSMENT

Data

Data sources have been extensively reviewed by CSAS (DFO 2012; DFO 2015; DFO 2016). Data, WSP metrics and supplementary information were updated from the 2012 Fraser Sockeye assessment (DFO 2012) to include escapements and returns from 2011 to 2015.

Methods

Abundance-based Benchmarks for Cyclic CUs

Benchmarks were calculated for cyclic Fraser Sockeye Salmon CUs for each year of data available using a Larkin model which accounted for lagged density dependence among cycle lines. For example, when spawner abundances are high, density-dependence in the freshwater environment may result in reduced recruitment in subsequent cycle lines. To smooth out inter-annual variability in benchmarks due to annual changes in the lagged spawner abundances, cycle-line specific median benchmarks were calculated over the entire time-series for each cycle. Probability distributions were derived for Larkin-based benchmarks to capture uncertainties from model fitting. Similar to abundance-based benchmarks for non-cyclic CUs, benchmarks were presented across a range of probability levels (10% to 90%). For cyclic CUs, statuses on abundance metrics were calculated by comparing total spawner abundances in the most recent year of data with its corresponding cycle line's lower and upper Larkin benchmarks. Statuses were presented for each of the four cycle lines in the most recent generation across the probability distribution (10%, 25%, 50%, 75% and 90%).

Integrated Statuses

Nine individuals (DFO and non-DFO) participated in the status re-assessment process for Fraser Sockeye Salmon CUs. Individuals were selected based on their past experience in one or more of the three previous integrated status processes (Fraser Sockeye Salmon, Southern BC Chinook Salmon, or interior Fraser Coho) and their Fraser Sockeye Salmon or Pacific salmon biology and/or stock assessment expertise.

Participants were provided with a standard information package and a 1.5 hour training session, and then asked to independently designate integrated statuses for each Fraser Sockeye Salmon CU and provide a written rationale for each assessment. The final step in the status re-assessment process was to consolidate individual statuses and questionnaires in a group process. Where there was agreement across individual assessments of CU's a summary narrative was developed.

Group assessments were subsequently conducted to confirm status for those where there was agreement in the individual assessments, to develop the group's final integrated status for those CUs where statuses diverged among the individual participants (which could include one or more WSP status zones), and to complete expert narratives on the group's rationale for each status designation. Narratives recorded both individual statuses before and after the group meeting and the final CU status designation. All participants had the opportunity to review and approve the final statuses and narratives before publication.

Results

Abundance-based Benchmarks for Cyclic CUs

To enable status comparison for fisheries management applications, CUs were grouped into their four management groups: Early Stuart (E Stu) Early Summer (ES), Summer (S), and Late

(L). Annual benchmark estimates varied among cycle lines for some CUs (e.g., Shuswap-L) and over generations for other CUs (e.g, Takla-Trembleur-EStu and Takla-Trembleur-Stuart-S, and Quesnel-S in the 1990s). In particular, where the magnitude of cyclic dominance increased or declined over time, benchmarks tended to become more variable. Similar to abundance-based benchmarks for non-cyclic CUs, uncertainties in cyclic benchmarks were large, and 95% confidence intervals for the upper and lower benchmarks often overlapped, especially on sub-dominant and off-cycle lines.

Integrated Statuses

Statuses designated by individuals prior to group meetings tended to be similar to one another, and where they diverged, usually represented adjacent status zones. In the group meetings, participants reached agreement on integrated status designations for all 24 CUs (Table 2 and Figure 3). This re-assessment identified the following integrated statuses for Fraser Sockeye Salmon CUs: seven Red, two Red/Amber, five Amber, six Amber/Green, three Green, and one data deficient. Given its restricted geographic distribution, Widgeon-(river-type) will be a consistently Red status CU.

Status Narratives

Status zones on their own do not provide a complete overview of the factors that drive status for each CU, and which could influence subsequent WSP strategies. Interpretations of the summary data used by experts to integrate statuses were therefore recorded as status narratives (Table 3). These narratives provide the details underlying the final integrated status decisions; CUs with identical status designations can have different reasons underlying the status determination, which are communicated via narratives. These details will be important when the results of Strategy 1 (Standardized Monitoring of Wild Salmon Status) implementation are linked to Strategy 4 (Integrated Strategic Planning).

Status Comparisons

Status did not change for 12 out of 19 CUs between the current assessment and the previous 2012 assessment (Tables 2 and 4). Five CUs were consistently Red between assessments: Bowron-ES, Cultus-L, Takla-Trembleur-EStu, Taseko-ES, and Widgeon-(River-Type). Two CUs became Red in the current assessment: Harrison (U/S)-L and Seton-L (previously undetermined). Of the Red CUs, two (Taseko-ES and Widgeon-river type CUs) will be consistently Red, given their small distribution. Two CUs (Quesnel-S and Takla-Trembleur-Stuart-S) remained Red/Amber, similar to the previous assessment. The number of Green CUs decreased from five to three: the 2017 Green CUs include Chilko-S/Chilko-ES aggregate, Harrison (River-Type), and Pitt-ES. For the 2017 assessment, the statuses of six CUs improved: Nahatlatch-ES, Nadina-Francois-ES and Francois-Fraser-S, Chilliwack-ES, Anderson-Seton, and Pitt-ES.

Grouping of CUs into their four management groups (Early Stuart [EStu], Early Summer [ES], Summer [S], and Late [L]) are shown in Table 5. The Fraser Sockeye Salmon CUs are broadly organized into these groups based on the entry of adult Sockeye Salmon into the Fraser River, as they migrate upstream to their spawning grounds. The first group (EStu) is comprised of a single CU (Takla-Trembleur-EStu), which remains in the Red status zone (Table 5). The Early Summer Run includes two Red CUs, five that have improved in status, and one CU that has declined. The Summer Run group is comprised of CU statuses that are mixed, with half of the CUs falling into the Red or Red/Amber status zones, and half designated as Green or Amber/Green. The Summer Run group is typically the group providing most of the total allowable catch (TAC) on average. Late Run CUs have generally declined in status, with four out of six CUs in the Red to Amber status zones. This Late Run group comprises a high

proportion of the TAC once every four years (2014, 2018...), when the Shuswap-L CU (i.e. Adams River run) returns in high numbers.

To facilitate biological applications (e.g. development of hypotheses for mechanisms influencing status designations and CU abundance trends), CUs were grouped based on their spawning and rearing locations in the Fraser watershed (Table 6). In the upper Fraser River, CUs have remained generally poor in status (Red to Red/Amber) from 2012 to 2017, with the exception of CUs in the Nechako River which have improved to Amber/Green statuses from Red or Red/Amber during this period. Overall, Mid-Fraser CU status was stable between assessments, and generally fell in the Amber to Green status zones; Lower-Fraser CUs were mixed in status. Particularly noteworthy is the decline in status of the Harrison Lake-rearing CUs since the 2012 status assessment: Harrison (U/S)-L (declined from Amber to Red), Harrison (D/S)-L (declined from Green to Amber/Green) and Lillooet-Harrison-L (declined from Green to Amber).

Status Integration Approaches

Individuals were able to develop a consistent approach to integrate status information across metrics and supplementary information for Fraser Sockeye Salmon CUs. No single metric alone, in the absence of the consideration of additional metrics and supplemental biological information, drove the integrated status designations. The process was likened to checking a patient for symptoms, starting with key vital signs (i.e. the WSP metrics), and then scanning for other signs of any underlying problems (i.e. supplemental information).

While their broad approaches to integration differed, individuals incorporated a number of considerations consistently:

- For CUs with recruitment data, the WSP abundance metric was a key piece of information that was heavily relied upon. This metric was generally given a higher weight in status determinations. Absolute abundance relative to COSEWIC criteria for small populations (1,000 individuals; COSEWIC 2015) was also relied upon for status assessments.
- The long-term trend metric generally did not influence status determinations, and the interpretation of the long-term trend metric relied heavily on trends in CU productivity (recruits/spawner), abundance (spawners and returns), and fishing mortality.
- The short-term trend in abundance metric, generally relied upon by COSEWIC to assess status across species in Canada, was also given low weight in these WSP status assessments. Pacific salmon are short-lived and spawn once before dying. These factors contribute to extremely variable short-term trends in abundance, which can swing this metric's status between Red and Green frequently throughout the time series.

Sources of uncertainty

- Given uncertainties in the individual metric statuses, the integration and expert interpretation of all available information is required for status evaluations. Specifically, the short-term trend metric requires careful interpretation for Pacific salmon due to commonly observed short-term fluctuations in the abundance trends of these species. Sensitivity analyses are recommended for short-term trend metrics, to evaluate their sensitivity to the data used. For abundance benchmarks, simulation modelling is recommended to explore the effect of error in stock-recruitment data (catch, escapement, and run size adjustments) on benchmark estimation. Uncertainties in abundance and short-term trend metrics are addressed through the use of Bayesian statistics and the presentation of information probabilistically.
- Uncertainty in mechanisms driving cyclic dynamics was identified. The Larkin model was identified as the best tool to model the cyclic patterns given current knowledge. However,

when the biological mechanisms underlying these dynamics are determined, this model and associated benchmarks should be re-evaluated. The Larkin model and associated benchmarks assume that abundances are limited by delayed density-dependence. However, empirical support for delayed density-dependence is lacking for many CUs, creating uncertainties in the application of Larkin benchmarks. Given the current uncertainty in the underlying mechanisms driving cyclic patterns, Larkin-based abundance statuses are considered similar to other metrics as one of several sources of supporting information for determining appropriate CU status. Within this greater context, Larkin model benchmarks use is recommended for future status re-assessment processes on Fraser Sockeye Salmon cyclic CUs.

- For all model-based abundance metrics there is uncertainty in the estimated parameters of models used for benchmarks; further work is recommended to explore these potential biases (time series bias).

CONCLUSIONS AND ADVICE

This process was the first re-assessment of WSP status, using Fraser Sockeye Salmon CUs as case studies. The following conclusions and advice are provided:

- New abundance benchmarks for cyclic stock CUs (Chilliwack-ES, Takla-Trembleur-EStu, Shuswap-ES, Takla-Trembleur-Stuart-S, Quesnel-S, Shuswap Complex-L) were estimated using the Larkin model; for each cyclic CU, the abundance metric's statuses were presented for each of the four cycle lines from the 10% to 90% probability level; a single integrated status was designated for each cyclic CU using this abundance metric information, combined with other abundance and trend metrics and information presented in the data summaries.
- The Larkin model accounts for density-dependence among cycle lines, and is suitable for those CUs with cyclic dynamics. Although the mechanisms underlying cyclic patterns are not well understood and may vary by CU, benchmarks derived from the Larkin model better capture cyclic dynamics than Ricker benchmarks. When used in an expert-driven process and multi-dimensional metric context, Larkin-model benchmarks for cyclic CUs are recommended for future status assessments.
- Integrated statuses for the 24 Fraser Sockeye CUs (Tables 2-6) and the associated narratives (descriptions of the information used to assess status) that result from the status integration process were provided (Table 3), based on updated data summaries including escapement data up to 2015.
- The status re-assessment process identified the following integrated statuses for Fraser Sockeye Salmon CUs (Tables 2-6): seven Red; two Red/Amber; five Amber; six Amber/Green; three Green; one data deficient.
- The combination of CU statuses, data summaries, and narratives are recommended as inputs into the WSP Strategy 4 (Integrated Planning); as a package, this information can be used to guide recovery actions among the Red, Red/Amber, and possibly Amber CUs, where applicable, and also guide management actions (fisheries, salmonid enhancement, and habitat) that affect CUs in any status zone; CUs and their 2017 statuses are grouped into run timing (management) groups in Table 5 to assist with fisheries management processes; to facilitate biological applications (e.g. development of hypotheses for mechanisms influencing status designations and CU abundance trends), CUs were grouped based on their spawning and rearing locations in the Fraser watershed.

- The following recommendations for future status re-integration processes across all species are provided:
  - For Fraser River Sockeye, it is recommended that data summaries are updated annually and reviewed by CU expert(s); it is also recommended that re-assessments be conducted every generation and/or when a notable change in productivity has occurred that could accelerate changes in the previous status designations; therefore, in the case of Fraser Sockeye the next complete status re-assessment should be conducted in 2021, unless evidence of a major productivity shift is detected in the interim years.
  - The current process demonstrates the effectiveness of using a smaller assessment group, and an iterative combination of individual and group work. This model was determined to be applicable for future assessments, and future assessment groups may benefit from participation of individuals with past WSP status experience, participants new to the process, and those with broader cross-salmon-species expertise to facilitate a more rigorous review of approaches.
  - This process demonstrated that for smaller-scale re-assessments, non-'blind' approaches, where the identity of the CU is known prior to an assessment being made, garner equally plausible results to the previous method of revealing the CU after assessment.
  - Each metric's status should be evaluated within the greater context of salmon-expert opinion on data quality, the retrospective stability of that metric's status over time, and patterns in abundance, productivity, and exploitation. As concluded in past processes, there is no simple algorithm that can be applied to determine an integrated status from all the individual metric statuses and supporting information. Since different factors may drive status for each CU, narratives and accompanying data summaries provide the context required to explain the logic of the resultant statuses.

Table 1. 2017 Fraser Sockeye Salmon CU list (see Grant et al. 2011 for details). The Nadina-Francois-ES CU has been updated after discussions with DFO's Salmonid Enhancement Branch (SEP: D. Lofthouse and D. Willis) and DFO's Fraser Sockeye Salmon Stock Assessment Program (K. Benner, T. Cone, and S. Grant).

Current	***New***	***Validation Required***	***Extirpated***
1. Anderson-Seton-ES	1. N. Barriere-ES	1. Cariboo-S (extirpated?)	1. Adams-ES
2. Bowron-ES	2. Seton-L		2. Alouette-ES
3. Chilko-S	-	2. Nadina-Francois-ES (first-run and second-run: are these separate populations or extirpated CUs?)	3. Coquitlam-ES
4. Chilko-ES	-		4. Fraser-ES
5. Chilliwack-ES	-		5. Kawkawa-L
6. Cultus-L	-		6. Morrich-ES
7. Francois-Fraser-S	-	3. Indian/Kruger-ES (extirpated?)	7. North-Barriere-ES
8. Harrison (D/S)-L	-		8. Seton-S
9. Harrison (U/S)-L	-	4. Middle Fraser (River-Type) (DNA required to confirm this is a unique CU)	
10. Harrison (River-Type)	-		
11. Kamloops-ES	-	5. Upper Fraser (River-Type) (DNA required to confirm this is a unique CU)	
12. Lillooet-Harrison-L	-		
13. Nadina-Francois-ES	-	-	-
14. Nahatlatch-ES	-	-	-
15. Pitt-ES	-	-	-
16. Quesnel-S	-	-	-
17. Shuswap-ES	-	-	-
18. Shuswap-L	-	-	-
19. Takla-Trembleur-EStu	-	-	-
20. Takla-Trembleur-Stuart-S	-	-	-
21 Taseko-ES	-	-	-
22. Widgeon (River Type)	-	-	-

Abbreviations: EStu: Early Stuart; ES: Early Summer; S: Summer; L: Late

Table 2. The 2017 Integrated status designations for the 24 Fraser River Sockeye Salmon CUs, ranked from poor (Red zone) to healthy (Green zone) status based on the current 2017 assessment. Cyclic CU statuses are determined including abundance benchmarks estimated using the Larkin model. For each CU, more commonly used stock names are presented. Cyclic CUs are identified. An asterisk (*) indicates provisional status designations; R/A: Red/Amber; A/G: Amber/Green; DD: data deficient; Undet: undetermined. The previous assessment's integrated statuses are also listed in the 2012 column (Grant and Pestal 2012).

2017	2012	Conservation Unit	Cyclic	Stock
R	R	Bowron-ES	-	Bowron
R	R	Cultus-L	-	Cultus
R	R	Takla-Trembleur-EStu	cyclic	Early Stuart
R	R*	Taseko-ES	-	Miscellaneous Early Summers
R	R	Widgeon – River*	-	Miscellaneous Lates
R	A	Harrison (U/S)-L	-	Weaver
R	UD	Seton-L	-	Portage
R A	R A	Quesnel-S	cyclic	Quesnel
R A	R A	Takla-Trembleur-Stuart-S	cyclic	Late Stuart
A	R	Nahatlatch-ES	-	Miscellaneous Early Summers
A	A	North Barriere-ES	-	Fennel and Miscellaneous Early
A	A	Kamloops-ES	-	Raft and Miscellaneous Early
A	A G	Shuswap-ES	cyclic	Scotch, Seymour, Mis. Early Summer
A	G*	Lillooet-Harrison-L	-	Birkenhead
A G	R	Nadina-Francois-ES	-	Nadina
A G	R A	Chilliwack-ES	cyclic	Miscellaneous Early Summers
A G	R A	Francois-Fraser-S	-	Stellako
A G	A	Anderson-Seton-ES	-	Gates
A G	G	Harrison (D/S)-L	-	Miscellaneous Lates
A G	G	Shuswap Complex-L	cyclic	Late Shuswap
G	A G	Pitt-ES	-	Pitt
G	G*	Chilko-S and Chilko-ES agg.	-	Chilko
G	G	Harrison River – River Type	-	Harrison
DD	DD	Chilko-ES	-	Chilko

Abbreviations: EStu: Early Stuart; ES: Early Summer; S: Summer; L: Late; Mis: miscellaneous;
**Widgeon (river-type) CU has a small distribution, therefore, this CU will be consistently in the Red status zone;*

Table 3: The 2017 Integrated status narratives for the 24 Fraser River Sockeye Salmon CUs, ordered by status zone from Red to Green.

2017 Status	Conservation Unit	Status Narrative (Key Drivers)
R	Bowron-ES	All metrics RED
R	Cultus-L	Rel Abd RED across all var., LT trend Red, 9 of 12 yrs
R	Takla-Trembleur-EStu	All metrics RED, declining prod
R	Taseko-ES	LT and ST trends RED, no rec est, so no Rel Abd BM
R	Widgeon – River*	Abs abd low, 3 of last 4 < 1000
R	Harrison (U/S)-L	All metrics RED, 2 of last 4 yrs <1000
R	Seton-L	Rel Abd RED (all vars), 2 of last 4 yrs < 1000, LT and ST
R AA	Quesnel-S	Rel Abd R/A mix (p-levels, cycles), ST RED, prod decl.
R A	Takla-Trembleur-Stuart-	Rel Abd R/A mix (p-levels, cycles), ST RED, prod below
A	Nahatlatch-ES	Abs Abd (median 2000, 1 of last 4 <1000), LT and ST
A	North Barriere-ES	Rel Abd AMBER (but LBM ~ 1000), LT GREEN, ST RED
A	Shuswap-ES	Rel Abd AMBER on dom line, LT and ST GREEN, prod
A	Kamloops-ES	Rel Abd AMBER (high unc), LT GREEN, ST RED (after
A	Lillooet-Harrison-L	Rel Abd AMBER, LT GREEN, ST RED, low prod, high abd
A G	Nadina-Francois-ES	Rel Abd AMBER at 50p, RED above, LT and ST GREEN,
A G	Chilliwack-ES	Rel Abd is AMBER, ST and LT trend GREEN, no yrs
A G	Francois-Fraser-S	Rel Abd is A/G mix, LT trend GREEN, ST trend AMBER
A G	Anderson-Seton-ES	ST and LT trend GREEN, Rel Abd AMBER for part of
A G	Harrison (D/S)-L	LT trend GREEN, ST trend RED coming off peak, no Rel
A G	Shuswap Complex-L	Rel Abd GREEN and Abs Abd large for dom cycle, stable
G	Pitt-ES	Rel Abd GREEN (all vars), LT GREEN, ST trend RED
G	Chilko-S and Chilko-ES	Rel Abd and LT trend GREEN, ST trend and prod.
G	Harrison River – River	Rel Abd GREEN at 50p, ST and LT trend green
DD	Chilko-ES	No independent data available (small part of Chilko

Abbreviations: EStu: Early Stuart; ES: Early Summer; S: Summer; L: Late; Mis: miscellaneous; Rel Abd: abundance; LT trend: long-term trend; R/A: Red/Amber; prod: productivity; Abs abd: absolute abundance; ST: short-term trend; prod below repl: productivity below replacement; prod incr: productivity increased; high unc: high uncertainty; abd: abundance; 50p: 50% (median) probability level of the benchmark distribution; no yrs: no years; A/G: Amber/Green;
**Widgeon (river-type) CU has a small distribution, therefore, this CU will be consistently in the Red status zone;*

Table 4. The 2017 Integrated statuses for the 24 Fraser River Sockeye Salmon CUs, organized by the degree of change since the previous assessment in 2012. CUs were given a numerical score that corresponded to their integrated status: 0=R (Red), 0.5=R/A (Red/Amber), 1=A (Amber), 1.5=A/G (Amber/Green) and 2=G (Green). The difference between the 2017 score and the previous 2012 score are ranked from the largest decline to the largest improvement in status.

	Status		Score			
Conservation Unit	**2012**	**2017**	**2012**	**2017**	**Diff**	**Change**
Harrison (U/S)-L	A	R	1	0	-1	decline
Lillooet-Harrison-L	G	A	2	1	-1	decline
Shuswap-ES	A/G	A	1.5	1	-0.5	decline
Harrison (D/S)-L	G	A/G	2	1.5	-0.5	decline
Shuswap Complex-L	G	A/G	2	1.5	-0.5	decline
Taseko-ES	R	R	0	0	0	no change
Cultus-L	R	R	0	0	0	no change
Bowron-ES	R	R	0	0	0	no change
Widgeon (River Type)	R	R	0	0	0	no change
Takla-Trembleur-EStu	R	R	0	0	0	no change
Quesnel-S	R/A	R/A	0.5	0.5	0	no change
Takla-Trembleur-Stuart-S	R/A	R/A	0.5	0.5	0	no change
North Barriere-ES	A	A	1	1	0	no change
Kamloops-ES	A	A	1	1	0	no change
Chilko-S/Chilko-ES agg.	G	G	2	2	0	no change
Harrison River (River-Type)	G	G	2	2	0	no change
Anderson-Seton-ES	A	A/G	1	1.5	0.5	improved
Pitt-ES	A/G	G	1.5	2	0.5	improved
Nahatlatch-ES	R	A	0	1	1	improved
Francois-Fraser-S	R/A	A/G	0.5	1.5	1	improved
Chilliwack-ES	R/A	A/G	0.5	1.5	1	improved
Nadina-Francois-ES	R	A/G	0	1.5	1.5	improved
Chilko-ES	DD	DD	Na	Na	Na	Na
Seton-L	UNDET	R	Na	Na	Na	Na

Abbreviations: EStu: Early Stuart; ES: Early Summer; S: Summer; L: Late; R: Red; R/A: Red/Amber; A: Amber; A/G: Amber/Green; G: Green; DD: data deficient; UNDET: undetermined; Na: not applicable;

Table 5. The 2017 Integrated statuses for the 24 Fraser River Sockeye Salmon CUs, organized by the run timing group used for fisheries management. CUs were given a numerical score that corresponds to their integrated status: 0=R (Red), 0.5=R/A (Red/Amber), 1=A (Amber), 1.5=A/G (Amber/Green) and 2=G (Green). The difference between the 2017 score and the previous 2012 score are ranked from the largest decline to the largest improvement in status within each run timing group.

	Status		Score				
Conservation Unit	2012	2017	2012	2017	Diff	MGMT GROUP	Change
Takla-Trembleur-EStu	R	R	0	0	0	Early Stuart	still Red
Shuswap-ES	A/G	A	1.5	1	-0.5	E Summ	decline
Taseko-ES	R	R	0	0	0	E Summ	still Red
Bowron-ES	R	R	0	0	0	E Summ	still Red
North Barriere-ES	A	A	1	1	0	E Summ	still Amber
Kamloops-ES	A	A	1	1	0	E Summ	still Amber
Anderson-Seton-ES	A	A/G	1	1.5	0.5	E Summ	improved
Pitt-ES	A/G	G	1.5	2	0.5	E Summ	improved
Nahatlatch-ES	R	A	0	1	1	E Summ	improved
Chilliwack-ES	R/A	A/G	0.5	1.5	1	E Summ	improved
Nadina-Francois-ES	R	A/G	0	1.5	1.5	E Summ	improved
Chilko-ES	DD	DD	Na	Na	Na	E Summ	still DD
Widgeon (River Type)	R	R	0	0	0	Summer	still Red
Quesnel-S	R/A	R/A	0.5	0.5	0	Summer	still R/A
Takla-Trembleur-Stuart-S	R/A	R/A	0.5	0.5	0	Summer	still R/A
Chilko-S and Chilko-ES agg.	G	G	2	2	0	Summer	still Green
Harrison River (River-Type)	G	G	2	2	0	Summer	still Green
Francois-Fraser-S	R/A	A/G	0.5	1.5	1	Summer	improved
Harrison (U/S)-L	A	R	1	0	-1	Late	declined
Lillooet-Harrison-L	G	A	2	1	-1	Late	declined
Harrison (D/S)-L	G	A/G	2	1.5	-0.5	Late	declined
Shuswap Complex-L	G	A/G	2	1.5	-0.5	Late	declined
Cultus-L	R	R	0	0	0	Late	still Red
Seton-L	UNDET	R	Na	0	Na	Late	declined

Abbreviations: EStu: Early Stuart; ES or E Summ: Early Summer; S: Summer; L: Late; R: Red; R/A: Red/Amber; A: Amber; A/G: Amber/Green; G: Green; DD: data deficient; UNDET: undetermined; Na: not applicable;

Table 6. The 2017 Integrated statuses for the 24 Fraser River Sockeye Salmon CUs, organized by Area. CUs were given a numerical score that corresponds to their integrated status: 0=R (Red), 0.5=R/A (Red/Amber), 1=A (Amber), 1.5=A/G (Amber/Green) and 2=G (Green). The difference between the 2017 score and the previous 2012 score are ranked from the largest decline to the largest improvement in status within each Area.

	Status		Score				
Conservation Unit	**2012**	**2017**	**2012**	**2017**	**Diff**	**AREA**	**Change**
Widgeon (River Type)	R	R	0	0	0	1. L.Fraser-Pitt	still Red
Pitt-ES	A/G	G	1.5	2	0.5	1. L.Fraser-Pitt	improved
Cultus-L	R	R	0	0	0	2. L.Fraser-Chllwck	still Red
Chilliwack-ES	R/A	A/G	0.5	1.5	1	2. L.Fraser-Chllwck	improved
Harrison (U/S)-L	A	R	1	0	-1	3. L.Fraser-Harr	declined
Lillooet-Harrison-L	G	A	2	1	-1	3. L.Fraser-Harr	declined
Harrison (D/S)-L	G	A/G	2	1.5	-0.5	3. L.Fraser-Harr	declined
Harrison River (River-Type)	G	G	2	2	0	3. L.Fraser-Harr	still G
Nahatlatch-ES	R	A	0	1	1	4. M.-Fraser-Nah.	improved
Anderson-Seton-ES	A	A/G	1	1.5	0.5	5. M.-Fraser A/S	improved
Seton-L	UNDET	R	Na	Na	Na	5. M.-Fraser A/S	now Red
North Barriere-ES	A	A	1	1	0	6. Thompson-North	still A
Kamloops-ES	A	A	1	1	0	6. Thompson-North	still A
Shuswap-ES	A/G	A	1.5	1	-0.5	6. Thompson-South	decline
Shuswap Complex-L	G	A/G	2	1.5	-0.5	6. Thompson-South	decline
Taseko-ES	R	R	0	0	0	7. M.-Fraser-Chilko	still Red
Chilko-S/Chilko-ES agg.	G	G	2	2	0	7. M.-Fraser-Chilko	still G
Chilko-ES	DD	DD	Na	Na	Na	7. M.-Fraser-Chilko	still DD
Quesnel-S	R/A	R/A	0.5	0.5	0	8. U. Fraser-Quesnel	still R/A
Francois-Fraser-S	R/A	A/G	0.5	1.5	1	9. U. Fraser-Nechako	improved
Nadina-Francois-ES	R	A/G	0	1.5	1.5	9. U. Fraser-Nechako	improved
Takla-Trembleur-EStu	R	R	0	0	0	10. U. Fraser-Stuart	still Red
Takla-Trembleur-Stuart-S	R/A	R/A	0.5	0.5	0	10. U. Fraser-Stuart	still R/A
Bowron-ES	R	R	0	0	0	11. U. Fraser	still Red

Abbreviations: EStu: Early Stuart; ES or E Summ: Early Summer; S: Summer; L: Late; R: Red; R/A: Red/Amber; A: Amber; A/G: Amber/Green; G: Green; DD: data deficient; UNDET: undetermined; Na: not applicable; L.Fraser-Chllwck: Lower Fraser-Chilliwack; L.Fraser-Harr: Lower Fraser-Harrison; M.-Fraser-Nah.: Mid-Fraser-Nahatlatch; M.-Fraser A/S: Mid-Fraser Anderson/Seton; M.-Fraser-Chilko: M.-Fraser: Mid-Fraser; U.Fraser-Upper Fraser.

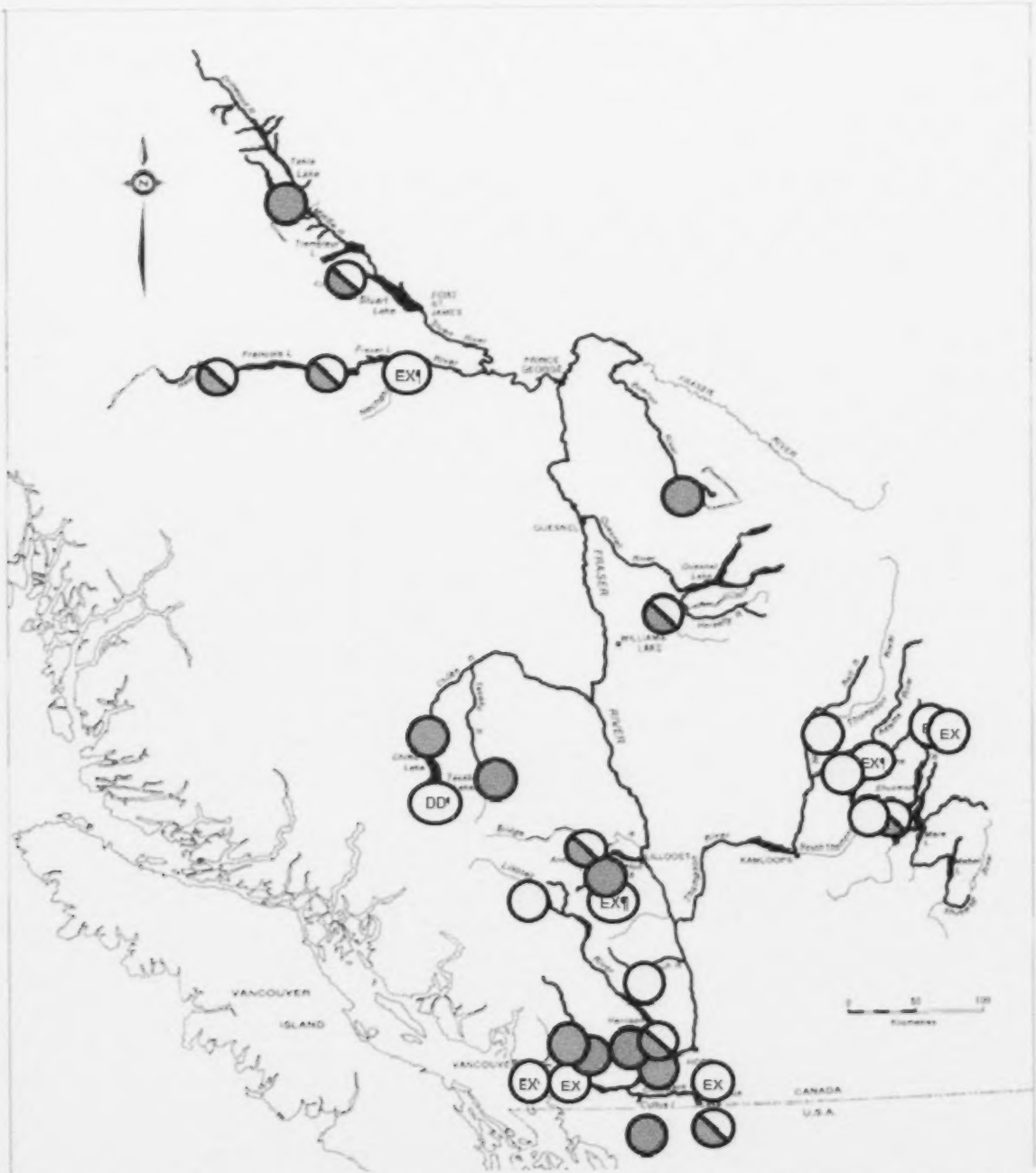

Figure 3. Map of the spawning distribution (darkened black lines) of Fraser River Sockeye Salmon CUs in south-western British Columbia with the 2017 integrated statuses indicated for each CU (see preceding table 4). There is one data deficient CU (DD) (Chilko-ES), as well as the 8 extirpated CUs (EX), indicated on the map.

SOURCES OF INFORMATION

This Science Advisory Report is from the June 6 and 7, 2017 Fraser Sockeye Wild Salmon Policy Integrated Biological Status Re-Assessment. Additional publications from this meeting will be posted on the Fisheries and Oceans Canada Science Advisory Schedule as they become available.

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MPO. Nouvelle évaluation de 2017 de l'état biologique intégré du saumon rouge du fleuve Fraser (Oncorhynchus Nerka) selon la Politique concernant le saumon sauvage. Secr. can. de consult. sci. Avis sci. 2018/017.